A

PLAN

OF A

COURSE OF LECTURES

ON

MINERALOGY,

TO WHICH IS PREFIXED

AN ESSAY

ON THE DIFFERENT KINDS OF

MINERAL COLLECTIONS,

TRANSLATED FROM THE GERMAN OF PROFESSOR WERNER.

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MDCCXCII.

PREFACE.

THE following pages are publiſhed with a view, to excite the attention of the Univerſity to a Branch of Knowledge, which although honoured with an eſtabliſhment in this place for a conſiderable number of years, has hitherto been ſuffered to languiſh in unmerited obſcurity. Abroad it has met with a better fate, and is now become the favourite purſuit of the moſt celebrated Natural Philoſophers and Chemiſts both of France and Germany. It muſt indeed be confeſſed, that notwithſtanding we have produced ſome Naturaliſts of the firſt rank from the Univerſity of Cambridge, yet a taſte for Natural Hiſtory never ſeems to have been a prevailing one amongſt us. And I apprehend, this is not to be attributed to a want of inclination to engage in theſe ſtudies, but to the

want

want of opportunity to conſult and examine the different productions of Nature. The inſtitution of a public Muſeum under proper cuſtody and regulations would remove this obſtacle, and be the daily means of exciting the curioſity of the unlearned, and aſſiſting the reſearches of the ſcientific Inquirer into Nature. To what extent Collections in that Branch alone of Natural Hiſtory, which it has fallen to my province to cultivate, may be carried, and to what uſeful purpoſes applied, is ſufficiently explained in the valuable Eſſay of M. WERNER, which I have prefixed to the Syllabus After a peruſal of that Eſſay it will readily be concluded, that the Woodwardian Collection, which was made near a century ago, is but ill calculated to promote the ſtudy of Mineralogy in its preſent ſtate of improvement. Till very lately no additions of any conſequence in an oryctological ſenſe, have been made to this Cabinet. From his Grace the DUKE OF GRAFTON we have received a ſmall, but in many reſpects a valuable Collection of

Foſſils

Foſſils chiefly Native. It would be unpardonable in me, were I to omit this occaſion of expreſſing my obligations to JOHN HAWKINS Eſq; of this College, for many valuable ſpecimens and communications in this department of Natural Hiſtory: theſe I feel a pride in being able to aſcribe, as well to the friendſhip of the Donor, as to the zeal for the promotion of every ſpecies of uſeful knowledge, for which this Gentleman is ſo eminently diſtinguiſhed.

I am ſenſible of ſome omiſſions in the arrangement of Foſſils which is delivered in the Syllabus, and of many defects in the Geognoſtical part of it. I have not inſerted the *Pechblende* of Saxony, diſcovered by M. Klaproth to be the ſulphurated Ore of a new Metal which he calls the *Uranium*. GEOGNOSY is a ſcience yet in its infancy, when ingenious Men may with much more eaſe fabricate ſyſtems than confute them. But the exertions of many eminent Philoſophers abroad, are inceſſantly employed in reſcuing this ſcience from

from the hands of fiction and conceit, and eſtabliſhing it upon the firm baſis of obſervation. A better acquaintance with their labours and an examination of the great mineralogical Phænomena of Germany, will I truſt, render my future exertions more deſerving of the patronage of the Univerſity.

Trinity College, Cambridge,
June 24, 1792.

ON THE DIFFERENT

SORTS OF COLLECTIONS

OF WHICH A COMPLETE

CABINET OF FOSSILS

OUGHT TO CONSIST.

By A. G. WERNER,

INSPECTOR IN THE INSTITUTE OF THE MINING ACADEMY AT FREYBERG, 1778.

1. THE collecting of Minerals, which was first begun above two centuries ago*, has contributed in an extraordinary degree to the advancement of Mineralogy.

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For in the firſt place, a Collection of Minerals, when devoted to an examination and

logue of his collection, drawn up by himſelf and dedicated to Conrad Geſner, dated Torgau, Nov. 8, 1565, to be inſerted in Geſner's work De omni Foſſilium Genere Tiguri, 1565; where it is to be found at the beginning, under the title of Kentmanni Nomenclatura Rerum Foſſilium. From the wooden cut which he prefixed to his catalogue, in which is diſplayed the Cabinet which held the collection and his manner of diſpoſing it, we may infer, that it was not very conſiderable, as the Cabinet only conſiſted of 18 drawers, and each drawer of 2 diviſions in breadth. The whole collection contained however, including ſlags and many other productions of art together with marine bodies, in all 1595 articles. But ſince Kentman had ſo great an idea of his collection as to ſay in his dedication, "Theſaurum Foſſilium multis impenſis collegerim *paucis comparabilem*;" and as at that time it was held in ſuch reputation, that Jacob Fabricius (not George as Denſo ſays in the 1ſt vol. of his Phyſicaliſchen Bibliothek. p. 118,) undertook a journey from Kemnitz to Torgau on purpoſe to ſee it, and gives it great preference in the dedication of his Brother's book De metallicis Rebus, we may conclude that there were collections before his time, but that the practice was then in its infancy.

From the number of Foſſils which Agricola, when compared with his predeceſſors, has made mention of in his treatiſe De Natura Foſſilium, from the order in which he treats them, from the external characters which he notices firſt almoſt of all and from the native places which he annexes, I conjecture that this learned man poſſeſſed already a collection, which was of ſervice

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and inquiry into their nature, very much facilitates the ſtudy of Mineralogy, as thereby, provided ſufficient knowledge and taſte has been diſplayed in the choice of exact and deciſive ſpecimens, we obtain the natural appearances of Foſſils in perfection; whilſt

to him in compoſing his book. In the dedication prefixed to it he ſays, " Sed cum noſtræ venæ non gignant omnis generis res Foſſiles, eas quæ nobis deſunt non modo a Germaniæ regionibus, quæ iis abundant, verum ab omnibus ferme Europæ partibus, a quibuſdam Aſiæ et Africæ apportandas curavi. In quibus negotiis conficiendis, mihi et docti homines et mercatores et metallici operam navarunt." And afterwards, in the dedication annexed to his Interpretatio Rerum metallicarum, he mentions the learned men who had tranſmitted Minerals to him; which places the buſineſs beyond all doubt. That this collection of Agricola was the firſt, is a mere conjecture, which however is extremely probable, as we find not the leaſt information of any before it, and the mineralogical writings of his predeceſſors are of that nature, that we may eaſily imagine they had no collection before them in their compoſition. Agricola therefore, whoſe intention was to carry Mineralogy to greater perfection than he had received it from preceding authors, might be the firſt to feel the neceſſity of making ſuch a collection, and conſequently the firſt to undertake it. Note of M. Werner, who has omitted to mention the collection of Minerals formed by Michael Mercatus in the 16th century and depoſited in the Vatican gardens at Rome, but of which the reader will find an account at the end of this Treatiſe.

whilſt on the contrary, the defective and inaccurate deſcriptions delivered in the writings of Mineralogiſts, ſupply us only with very inadequate conceptions of them: and in the next place, there prevails amongſt ſcientific collectors, a certain pride reſpecting the arrangement and completeneſs of their Cabinets, and the poſſeſſion of ſcarce Foſſils, that not only conſtantly tends to improve the Mineral ſyſtem itſelf, but is likewiſe the occaſion of making known many new Varieties, and even Species of Minerals, to the curious in theſe reſearches.

2. Such an aſſortment of Foſſils is uſually denominated a Cabinet of Minerals; probably from the places in which theſe collections were depoſited at the time when they were very ſmall, namely, the ſmall Cabinets which make part of the furniture of the larger rooms.

3. With reſpect to their object, ſome collectors, by the inſtitution and poſſeſſion of a ſplendid Cabinet of Minerals, ſeek merely the reputation of being men of wealth and taſte and encouragers of ſcience.

And

And although the motive in this caſe be an undoubted piece of vanity, yet it is the more readily to be excuſed as a foible from which no one is intirely free; and which may be turned with great effect to the advantage of mankind, in the promotion of a very uſeful branch of knowledge.

Other collectors again, are influenced by the benevolent deſign of affording to the Public an opportunity of inſtruction in the knowledge of Foſſils, and particularly to the inquiſitive Mineralogiſt the means of making new obſervations in the ſcience, or of confirming ſuch as have been already made. With theſe views ſuch collectors generally unite a genuine love of Mineralogy, and make the examination of their Cabinets ſubſervient to their amuſement and recreation. They are diſtinguiſhed from the firſt ſort by the facility with which they grant admiſſion to their collections, and their readineſs to receive advice in the arrangement of them.

But collectors for the moſt part have ſolely in view their own particular benefit

and improvement in the ſtudy of Mineralogy; and ſince to this motive the deſign of imparting their acquiſitions in this branch of knowledge is almoſt inſeparably annexed, ſo much the more laudable is their object, in the inſtitution and maintenance of their collections. They deſerve therefore the ſupport of every lover of Mineralogy, in proportion to the zeal and talents which they diſplay in accompliſhing the object of their purſuits. I am at a loſs whether I ſhould take notice of thoſe who collect Minerals for the purpoſes of ſale, or paſs them over; I ſhall chuſe the latter.

4. As therefore *Inſtruction in Mineralogy* is the chief object of a Mineral Cabinet, ſo next to its completeneſs, the principal property which it is expected to poſſeſs is a *Diſpoſition and Arrangement* ſuitable to the purpoſes of its inſtitution.

But as *Mineralogy*, or the univerſal knowledge of Foſſils, may be reſolved into ſeveral particular branches, correſponding to particular properties of Foſſils, each of which conſtitutes a peculiar ſcience which muſt

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be taught after a different method, it becomes requiſite to appropriate a ſeparate collection to each ſcience, the arrangement of which muſt be conformable to the ſyſtem of that ſcience, whoſe particular cultivation the collection is intended to promote. For the Order which is adapted to advance one branch of this ſtudy, is in general the reverſe of what another branch requires. The idea therefore of forming a ſingle collection of Minerals, which ſhall be equally ſuited to all the different ſciences comprehended in Mineralogy, muſt be totally abandoned; and even a collection which might be chiefly diſpoſed for promoting one of theſe ſciences, but yet in ſome reſpects had an application to another, would be imperfect as far as this circumſtance extended.

5. An univerſal knowledge of Foſſils, or *Mineralogy* in general, comprehends,

1. *The Knowledge of the Characters of Foſſils.* Characteriſtica mineralogica.
2. *The Knowledge of Foſſils themſelves.* Oryctognoſia.

3. *The Knowledge of the Earth's internal Structure.* Geognoſia.
4. *Mineralogical Geography.* Geographia mineralogica.
5. *Oeconomical Mineralogy.* Mineralogia Oeconomica.

And a complete *Cabinet of Minerals*, when adapted to the ſtudy of all theſe diſtinct ſciences, muſt conſiſt of *as many diſtinct Collections*. viz.

1. *A Characteriſtical* Collection
2. *A Methodical* Collection.
3. *A Geological* Collection.
4. *A Geographical* Collection.
5. *An Oeconomical* Collection.

6. A *characteriſtical Collection*, or one in which the ſubſtances are wholly arranged according to a ſyſtem of characters, ſerves for the ſtudy of *the Characters of Foſſils*, which is of indiſpenſable uſe in Oryctognoſy, and furniſhes the means *of Deciſion in thoſe Caſes where a Character is doubtful.* This collection is placed firſt, becauſe it is the

the firſt that is required in the ſtudy of Mineralogy. For before we can tell how many ſpecies of Foſſils exiſt — how they follow each other in a natural order — in what circumſtances they differ — how and in what beds produced — where they are found and to what uſes applied — before all theſe particulars can be learnt, we muſt make ourſelves well acquainted with their characters, that is, the properties by which they can be known and diſtinguiſhed from each other.

Such a collection muſt be intirely diſpoſed according to a ſyſtem of the characters of Foſſils, and as the chemical, philoſophical and empirical characters are but few, principally according to the external characters, in ſuch an order, that whoever ſhall have the inſpection of this Cabinet may have at once the whole ſyſtem before his eyes. The articles therefore in this collection muſt follow not only in the order of the generical characters, ſo that thoſe be placed firſt which ſerve for

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the explication of the COLOUR, next of the FIGURE, and ſo on, but alſo all the ſpecimens belonging to each *generical Character* muſt be further arranged according to their *ſpecific Characters*, and again the varieties and ſub-varieties muſt be duly placed in the order of their mutual tranſitions one into the other. In aſſorting and arranging this collection the Eſſay on the *external Characters of Foſſils* printed at Leipzig, 1774, may be made uſe of.

The principal attention required in forming this collection, is to ſelect thoſe ſpecimens only, in which the character that they are intended to exhibit may be clearly and deciſively recogniſed. Hence it is not neceſſary that every Foſſil ſhould be found therein, but ſuch only as ſerve for the elucidation and explication of their ſeveral characters. Not only many varieties, nay perhaps the greateſt number, and even ſome intire ſpecies may be diſpenſed with: thus the white copper ore, the Nagyag ore and the bituminous argillaceous ſlate will

have

have no place, as none of theſe Foſſils poſſeſs any character marked with ſufficient diſtinctneſs.

On the contrary, many ſpecies as well as varieties may occur in various places and under various characters, according as they exhibit different characters with the neceſſary degree of evidence; thus the *Smoke-grey Flint* may be placed 1ſtly under the GREY COLOURS, 2dly under that ſpecies of Luſtre called SCINTILLATING, 3dly under the CONCHOIDAL FRACTURE, 4thly under the TRANSLUCID Foſſils, 5thly under the HARD, and 6thly under the NOT PARTICULARLY HEAVY; for in it all theſe external characters are plainly and deciſively to be diſcerned. It is wholly indifferent whether the native places of the ſpecimens contained in this collection be known or not. Ignorance or uncertainty in this reſpect does not leſſen its utility.

It is of advantage to have always more than one, and even four or five ſpecimens of each variety in the collection; as of the *Lead-grey Colours*, Galena, Molybdena, Vitreous

treous Copper ore, grey ore of Antimony: for beginners in general form an abſtract conception of a character from a ſingle example with difficulty; it will be always more or leſs combined with others in the ſame ſpecimen or ſpecies, and when the character occurs in another Foſſil and in combination with different characters they are frequently at a loſs to recognize it.

This collection is the ſmalleſt of all, and two Cabinets* holding forty or at the utmoſt forty four drawers will contain ſufficient room for the moſt extenſive. To all *Teachers of Mineralogy*, and eſpecially *thoſe who communicate deſcriptions of Foſſils to the Public*, it is abſolutely indiſpenſable; to the other lovers of Mineralogy who have it in their power to form ſuch a collection for themſelves, it is at all times uſeful and inſtructive.

7. *A methodical Collection* is that, in which Minerals are arranged after their mutual relation

* The dimenſions of the drawers of a German Cabinet, here ſpoken of, are depth or length inſide 20 inches. Breadth inſide 18 inches. Height inſide 2½ inches.

relation of genera and ſpecies in a natural order. It occupies *the ſecond place* amongſt the ſeveral Mineral collections, as Oryctognoſy to which it is ſubſervient does amongſt the mineralogical Sciences, and ſerves for the *ſtudy of the Mineral ſyſtem* and *the formation of the external conception of each ſpecies of Foſſil.*

In this collection the articles muſt lie not only as the ſpecies ſucceed each other in a natural order, that is according to the proportions of the ingredients in their mixture, but the varieties alſo of each ſpecies muſt be diſpoſed according to the external characters, in ſuch a manner as to preſent at once the intire image of that ſpecies to the view. This will be accompliſhed, if in a ſpecies which is varied in ſome of its characters, the varieties which belong to a generical character, the colour or the fracture for inſtance, be firſt collected together and placed in the order of their mutual tranſitions one into the other; and next if the generical characters that are varied, be placed in the ſame order as

they ſucceed in the ſyſtem of external characters, ſo that in each drawer the varieties of one character may be eaſily ſeparated and diſtinguiſhed from thoſe of another.

This collection may be always diſpoſed according to that ſyſtem of Mineralogy, which is in moſt repute at the time.

In a methodical Collection, we muſt endeavour to poſſeſs not only all the ſpecies of Foſſils, but alſo all the varieties of each ſpecies as complete as poſſible. And the ſpecimens of each variety ſhould be perfectly diſtinct and in good preſervation. The Foſſil ſubſtance therefore for which the ſpecimen in the collection is intended, ſhould be as clean and as little contaminated with other ſubſtances, as it is poſſible to procure it.

Although the completeneſs of a methodical Collection conſtitutes its principal excellence, yet by an unneceſſary degree of extenſiveneſs and a ſuperfluous number of Minerals, it may notwithſtanding loſe much of its value: for thereby the inſpection of an intire ſpecies is rendered more labo-

laborious, and the moſt important varieties cannot ſo readily be diſtinguiſhed. All thoſe ſpecimens therefore which do not exhibit a peculiar variety or ſub-variety, and which were formerly placed in this Collection merely on account of their being found in a different ſort of ſtone or ore, muſt be excluded. For the ſame reaſon no aggregate ſubſtance belongs as a particular Foſſil to this collection, ſince no aggregated Foſſils can be admitted into a Mineral ſyſtem as diſtinct ſpecies on account of their aggregation. Whoever would therefore inſert *Granite* in a methodical collection muſt either place it on account of its Feldſpath amongſt the varieties of that ſtone, or on account of its Mica amongſt the varieties of that Foſſil, or laſtly on account of the Quartz amongſt the varieties of Quartz; but as a peculiar ſtone compoſed of theſe ſeveral ſpecies it does not appertain to this but the following or Geological Collection. Juſt as little title to a place in it have artificial ſubſtances,

ſtances, and bodies taken from the other kingdoms of nature.

In a methodical Collection, the ſame Foſſil can occur only under one ſingle genus, and in that genus under one ſingle ſpecies, except indeed it ſhould accidentally adhere to a ſpecimen of another ſpecies. But in the ſpecies to which it belongs the ſame Foſſil may be placed under two or even more varieties, ſhould it be neceſſary to complete their number. Thus amongſt the principal varieties of granular limeſtone, the *Snow-white Carrara Marble* may lie once under the varieties of *Colour* and again under the varieties of *Granular ſeparated Pieces.*

Although it may prove of advantage to be acquainted with the native place of every ſpecimen in this collection, yet it is not however abſolutely neceſſary; and ſome ſcarce varieties of a Foſſil will always preſerve their value, notwithſtanding this circumſtance ſhould be unknown.

A methodical Collection takes up much more

more room than the foregoing, and if intended to be very complete and on a great ſcale, will occupy 5 Cabinets containing 126 drawers in 14 rows. A ſmaller convenient one may be held in 3 Cabinets, which contain 76 drawers in 6 rows.

This collection is the moſt important of all others, and alike indiſpenſable to all thoſe who are employed in the cultivation of Mineralogy in general, or any of its branches in particular.

8. The third collection is the *Geological*, in which the Foſſils are arranged after the ſyſtem of the Earth's internal ſtructure, and applied to that branch of Mineralogy.

It is conſequently inſtituted for the ſole uſe of Geologiſts, who by its means are enabled, either to demonſtrate the propoſitions in the ſcience, deduce new conſequences, or finally derive aſſiſtance in the determination of any ſpecies of Rockſtone or Petrifaction, which may happen to be dubious.

This collection therefore exhibits firſt

the different ſpecies of Rocks belonging to the primary, the compound ſtratified or ſedimentary, the volcanic and the alluvial countries, with their ſeveral varieties. Theſe muſt be accompanied by the Foſſils which are moſt uſually to be found in them. Along with the Rockſtones of the compound ſtratified Countries lie the Petrifactions; the Metals ſucceed and thoſe Foſſils they are moſt commonly aſſociated with; laſtly come the articles from which we are enabled to deduce ſuch inferences, as tend to explain the origin of veins and fiſſures, and the riſe and generation of every Foſſil ſubſtance.

It is not neceſſary to annex their native places to the articles contained in this collection, we need only be careful that the examples of the Rocks of each Country be choſen freſh and unaltered, and that the ſpecimens of metallic ſubſtances, which are ſelected on account of the kinds of ſtone which ſerve as their matrix, exhibit them with ſufficient evidence and diſtinctneſs.

This collection is not indeed ſo extenſive

ſive as the methodical, but is always ſomewhat larger than the characteriſtical. For its eſtabliſhment and conſervation, a pair of Cabinets containing about 48 drawers will be ſufficient. Without this collection a great Cabinet of Minerals would be incomplete. And it could be ſo much the more eaſily formed, as hitherto it has been the cuſtom to place the greateſt part of the Foſſils which belong to it, viz. the Rocks and Petrifactions, as a ſupplement to the methodical collection, but which thereby becomes unneceſſarily diffuſe. To a teacher of Geology as well as to all others who are engaged in the cultivation of this ſcience it is likewiſe indiſpenſable.

9. The fourth collection of Minerals is the *Geological*, in which the Foſſils are placed in a Geographical order.

This is principally intended for the uſe of mineralogical Geographers, who thereby become acquainted with the Mountains that occur in different Countries, the Foſſils which theſe Mountains contain, and where and under what circumſtances

they are found. Many uſeful particulars in Geology alſo may be elucidated by its aſſiſtance.

The Foſſils therefore in ſuch a collection muſt be arranged geographically, that is, they muſt lie only in the order of the places where they are found, and in that of their reſpective ſituations. It muſt firſt therefore be divided in a general manner after the different Countries and their geographical order. But the Foſſils of each Country muſt not be arranged according to its political diviſions, but rather according to its Mountains, and thoſe of a Mountain according to its ſeveral diſtricts, and thoſe of a diſtrict, firſtly, after its particular diviſions, ſecondly, after the Mining Fields, thirdly, after the Mines which are found therein, fourthly, after the veins on which a Mine is worked, and fifthly, after the Shafts and Galleries upon the Veins, in proportion to the degree of extent it is intended that theſe ſeries of Foſſils ſhould poſſeſs. To give a ſhort ſketch of the arrangement of ſuch a col-

collection, I ſhould firſt begin with the more diſtant parts of the World, the ſouthern Countries beyond the line, America, Africa and Aſia. Then I would diſpoſe the European Countries perhaps in the following order. Portugal, Spain, France, Great Britain, Norway with its dependent Iſles, Sweden, Germany including Denmark, Holland, Switzerland, Bohemia, Moravia and Pruſſia; Poland, Ruſſia, Tartary, Turkey in Europe, Hungary with its ſubordinate Countries, Italy. The Country in which the collection is made, and on which conſequently moſt pains would be beſtowed, ſhould be placed out of the order and laſt in the ſeries. Suppoſe it for inſtance *Germany*, and in it particularly *Saxony*. In this caſe I ſhould begin in Germany on the north, where it approaches neareſt to Sweden, and arrange the different ſeries of its Mountains as follows. *Firſt*, the flat Country and compound ſtratified Hills of Swediſh Pomerania, Mecklenburg, Holſtein and Denmark. *Secondly*, the Hartz Mountains with

the remaining flat Country of lower Saxony on this ſide of the Elbe, together with the Magdeburg Hills and the reſt of Thuringia, as far as the Saale. *Thirdly*, the Naſſavian Mountains on the Rhine with the Weſterwalde, the remainder of Weſtphalia, Cologne and Treves, and the Netherlands. *Fourthly*, the Mountains of the Duchy of Deux-ponts and the Palatinate, with the adjacent flat Country. *Fifthly*, the Mountains of the Black Foreſt. *Sixthly*, Switzerland. *Seventhly*, the Auſtrian, Bavarian and Saltzburg Mountains. *Eighthly*, the Fichtel Mountain in Franconia, the upper Palatinate, with the upper parts of Thuringia and Heſſe, together with the compound ſtratified Hills and flat Country belonging to them. *Ninthly*, the Erzgebirge or Mining Mountains in Saxony, and thoſe in upper Luſatia, with the compound ſtratified Mountains and flat Country down to the Saale. *Tenthly*, the Bohemian and Moravian Mountains. *Eleventhly*, the Sileſian Mountains and the ſtratified and flat Country of that Province, the Marches of

Bran-

Brandenburg, Pomerania and Pruſſia. In the ſeries appertaining to Saxony, which I revert to as the laſt, for the ſake of purſuing it ſtill further in detail, I ſhould take firſt the Erzgebirge, and the flat Country of the Voigtland, Leipzig, Electoral and Meiſſner Circles, next the Mountains of upper and the flat Country of lower Luſatia. In the Erzgebirge I ſhould begin with the Neuſtadt and Kamsdorf Diſtricts, (including the Rothenburg near Saalfeld,) then I ſhould take the following Mine Diſtricts, Voigtberg, Eibenſtock, Schneeberg and John Georgenſtadt, beyond theſe Weiſenthal and Annaberg, then Schwartzenberg; next Geyer, Ehrenfriedersdorf and Marienberg, then Freyberg, and laſtly Altenberg, Gieſhubl, and Glaſhütte.

It would be exceeding the bounds of this Eſſay, were I further to purſue the diviſion of a Mining Diſtrict, after the ſeveral ridges into which nature has diſtributed it, and afterwards, according to its ſeveral ſtandard Courſes and Mines.

This collection, as may be eaſily ſeen, is beyond compariſon the moſt extenſive, and ſuch as it is impoſſible to render complete. For admitting the collector to poſſeſs ſufficient mineralogical and geographical knowledge of every Country, (which neither in our time or indeed in any other can be expected,) how is he to find an opportunity of procuring the Foſſils which are now found, and thoſe which may be hereafter diſcovered in the different Countries of Europe, to omit the other quarters of the Globe. And beſides, thoſe Foſſils would always be wanting which ceaſe to appear at the places where they were formerly found, and which nevertheleſs would amount to a conſiderable portion of the whole. As therefore a collection of this nature muſt neceſſarily be imperfect, each Mineralogiſt muſt confine his pains and attention to the ſeries of a particular Country, namely the Country in which the collection itſelf is formed; becauſe he will there have the beſt opportunities of rendering the ſeries as perfect as poſſible, and

and to the Mineralogiſts of that Country, (for whom indeed and not for Foreigners ſuch a collection is principally intended,) its Foſſil productions are of much greater conſequence than thoſe of any other part of the World. The ſeries of foreign Countries in general are ſmaller, and of courſe more imperfect, the greater the diſtance of the Country from that which is the chief object of the collection; on account of the difficulty in procuring their Minerals, which increaſes in the ſame proportion. Moreover theſe Foſſils are ſeldom of much conſequence to Mineralogiſts, becauſe the more diſtant the Country the leſs intereſting it becomes, and the fewer are the opportunities of employing the knowledge of its productions, which is to be derived from ſuch a collection.

Meanwhile with reſpect to the foreign ſeries, care muſt be taken, in the ſeries of a Chain of Mountains, to procure the ordinary Foſſils of *every well known or remarkable Spot*, moreover the *conſtituent Rock* whenever a new one occurs, and laſtly amongſt

amongſt its ſcarce productions only the beſt known and moſt remarkable. The ordinary Foſſils of the ſame Country muſt alſo be procured as much as poſſible with thoſe kinds of Stone or Earth, which for the moſt part accompany and peculiarly diſtinguiſh them. *In the Series belonging to our own Country*, inſtead of limiting our reſearches, as in the foreign, to the mining Provinces and their principal works, we muſt collect not only from every Mine, but alſo from the ſeveral Veins on which each Mine is worked. And indeed, if we were to form a *very particular Series* for a Mining diſtrict, it would require the collection of the principal ſubſtances found in each Shaft and Gallery on every Vein, whereon the Mine was worked. It would however be abſurd to preſerve all the little varieties of a Foſſil, which are perpetually occurring in one place only, or in one ſingle Vein; the ſeries would thereby become unneceſſarily diffuſe in the higheſt degree, and conſequently of leſs utility.

The ſpecimens in this collection need

not

not be choſen of the greateſt degree of beauty, nor rejected if they ſhould be in a ſomewhat worſe condition than thoſe belonging to the methodical Collection. It is ſufficient if the Foſſil, which a ſpecimen is properly meant to exhibit, can be eaſily diſtinguiſhed, and the uſual concomitant Foſſils, whereby the ſort is particularly indicated, are to be ſeen thereon in their due proportion. But the *native places* of the ſpecimens muſt be determined with the greateſt *accuracy* and *truth*, and therefore in the ſpecimens of *foreign* Metallic ſubſtances we muſt mark, not only the places in general but alſo the Mines, and where it can be done, the Veins from which they came: and in the *Series of the domeſtic* Metallic ſubſtances, eſpecially when intended to be very full and explicit, the Vein muſt conſtantly be mentioned, and in addition as far as poſſible the very place of it where, the time when, and the circumſtances under which the Ore was diſcovered, and to what extent it was worked.

It is impoſſible to determine with any pre-

preciſion the ſize of ſuch a collection, a very large one may require more than 80 Cabinets each conſiſting of 8 drawers, but a ſmall one may be contained in about 20 ſuch Cabinets. A collection of a middling ſize formed upon the plan which I have juſt been explaining, might perhaps occupy 43 of theſe Cabinets.

Theſe geographical Collections, as I have already ſaid, are principally for the ſervice of *mineralogical Geographers*; but what profeſſional teacher of the Science is in a condition to form them? amongſt the lovers of Mineralogy there are but few that have it in their power, or will undertake to form only a *ſmall collection of this nature*. And yet ſuch a one would not much aſſiſt the ſtudy of mineralogical Geography; the inſtitution therefore of great *Geological Cabinets* muſt be left in the hands of Kings and Princes, who thereby have the faireſt occaſion of erecting a monument for the benefit of their Country, which would immortalize their names, and enſure the grateful acknowledgement of every lover

of

of Mineralogy to the lateſt poſterity. *Collections* of a *middling extent* may however be formed by Univerſities and other public Societies of learned men: and ſurely where nature has diſtinguiſhed a Country by the production of uſeful Foſſils, and eſpecially by metalliferous Mountains, the Government is bound to maintain at leaſt ſuch a middle ſized collection. There ſhould alſo be preſerved in every mining diſtrict a complete *ſingle Series of its Foſſils* arranged upon the abovementioned principles, which in future times would prove the moſt uſeful memorial of the riches of each particular work, and at the ſame time ſerve to record many remarkable natural Phænomena. Theſe would be noticed by the travelling Mineralogiſt, who ſhould happen to tarry at the place, which might otherwiſe remain unknown and of no ſervice, to the great detriment of the Science.

10. The fifth ſort is the *Oeconomical Collection* in which the Foſſils are arranged, merely according to the different uſes to which they are applied.

The

The Minerals in ſuch a collection, may be diſtributed into four claſſes, correſponding to the different purpoſes for which they are employed.

1. Foſſils of vulgar Oeconomical uſe.
2. Foſſils which are worked, wrought, or in any manner employed in Manufactures, Arts, or Trades.
3. Foſſils from which Metals and Salts are prepared.
4. Foſſils which are uſed as Means for the extraction of Metals and Salts.

Each of theſe claſſes might be farther divided into Genera, and theſe again into Species.

The firſt claſs might be divided perhaps into the following Genera.

1. Stones for Building. 2. For Mortar. 3. For Roofing. 4. For Window-panes and the like. 5. For Plaiſtering. 6. For Flooring. 7. Paving. 8. Poſts and Paliſadoes. 9. Mending of Roads. 10. Melioration of Land in Agriculture. 11. Fuel. 12. For Lights. 13. For Perfumes. 14. Greaſing

14. Greaſing of Wheels. 15. Gun Flints. 16. For Filtring. 17. Preparation of Victuals and Liquor. 18. Writing Slates. 19. For Cattle.

The ſecond claſs might perhaps be divided into the following Genera.

1. Statuary and Stone-cutters Work. 2. Carving and Turning different Wares. 3. Poliſhing Stones. 4. Jewelry. 5. Modelling and Moulding. 6. Giving the colour of Bronze. 7. Pigments and Crayons, and Drawing in general. 8. Writing and Marking. 9. Lackering. 10. Bricks and Tiles. 11. Hard and Soft earthen Ware, and Delft. 12. Crucibles, and other Fire Veſſels. 13. Tobacco Pipes. 14. Porcellain. 15. Glazing. 16. Glaſs. 17. Blue colouring of Glaſs. 18. Enamelling. 19. Powder for cutting and poliſhing. 20. Grindſtones, Whetſtones and ſcouring Stones. 21. For Moulds. 22. Rubbing Stones and Mortars. 23. Miilſtones. 25. Floors of Stamping Mills. 26. Anvils. 27. Smoothing Stones. 28. Touchſtones. 29. Greaſing of Machines.

chines. 30. For Fulling and fetching out Grease. 31. Tanning. 32. Painting. 33. Soap-making. 34. Refining of Sugar. 35. Manufacture of Gunpowder. 36. Making of artificial Fireworks. 37. The Materia Medica. 38. Experiments in Natural Philosophy.

The third class may be disposed agreeably to the known Metals and Salts that are produced therefrom.

And the fourth class may be first divided into the two following Orders.

A. Materials for Fluxes.
B. Materials for the building of Furnaces.

The Fluxes might again be divided into Genera according to the different Salts and Metals for whose preparation they are employed.

It would take up too much time, were I to trace the species of each Genus, I shall therefore only just mention that *each Genus contains as many Species, as there are different Fossils applicable, to the use that is characteristic of the Genus.* Thus in the Genus of Fossils used

uſed for Cutting and Turning the ſpecies are Serpentine, Potſtone, Alabaſter, Steatites and indurated Stone-marrow.

The Foſſils which ſerve for writing and marking are Chalk, Black Shiver or Chalk, Black Lead, Reddle, Soapſtone, Argillaceous Slate.

Thoſe uſed for Fulling and taking out Greaſe are Fullers Earth, Soapſtone, White Clay.

The difference in the goodneſs of the ſeveral kinds of Foſſils makes the varieties in each ſpecies.

According to this ſyſtem ſhould the Oeconomical Collection be arranged. Where it may however be remarked, that the ſeveral ſpecies are to be diſpoſed in the order of their degrees of excellence, from good to worſe, for their reſpective uſes. And the ſame order is to be obſerved in placing the varieties.

Every Foſſil is not to be found in this collection, becauſe at preſent the œconomical uſes of all are not known. Thus Wolfram being at preſent applied to no

uſe, cannot be placed in an œconomical Collection. But yet many Foſſils repeatedly occur under various Genera. e. g. *Red Hæmatites* lies

1. Amongſt the Ores of Iron.
2. Amongſt the articles uſed in poliſhing.
3. In the Materia Medica.

Every Foſſil in this collection muſt have the place annexed where it is digged, or at leaſt the Country, together with the uſual price it bears. An œconomical Collection of Minerals of a convenient ſize, is as large as the methodical or perhaps ſomewhat larger.

A collection of this ſort is for the purpoſe of informing mankind, what Foſſils are uſeful in common life, and may on that account become proper objects of commerce: for what purpoſe alſo and by what artiſts each Mineral is uſed, the degree of its conſumption, the properties that are required in it to make it merchantable, the price it bears, and the Countries that have hitherto produced it. As all theſe par-

particulars belong to the different branches of financial and commercial knowledge, and principally to the commerce which relates to Mines, hence the inſtitution of an œconomical Cabinet is for the uſe of *Financiers* and *thoſe who traffic in mineral productions*, as well as for them *who teach the doctrines of political Oeconomy and Finance*. And care ſhould be taken to eſtabliſh ſuch collections in Univerſities, Academies and royal Foundations for Mining and Commerce, and in principal Mining Towns, for public uſe, from which the latter, and eſpecially the officers of Mines and Smelting works, might derive much uſeful knowledge and information.

The utility of this collection might be much augmented, if the products that are obtained from each Foſſil, and alſo the preparations of a Mineral, which is thereby rendered a fit article of commerce, were to be collected together with the ſubſtances in their natural ſtate and laid contiguous to them.

11. Of theſe five ſorts of Mineral collections, the firſt known and inſtituted was

undoubtedly the Methodical. At leaſt all the ancient collections, and indeed thoſe that have been formed in later times can be referred to no other claſs ſo eaſily as to this: for the Foſſils therein are chiefly divided according to their eſſential differences ſo far as they were known at the time, and follow each other in the order of their mutual relations in a greater or leſs degree.

But to ſpeak the truth, both the ancient and modern, the latter however in a leſs degree, are a curious medley of the four laſt collections, in which the arrangement of the methodical barely predominates, for independent of the ſyſtematical order on which they are conſtructed, in them we uſually find the ſeries of Rockſtones and Petrifactions; and moreover the articles belonging to any particular ſpecies of the metallic claſs, are arranged according to the kind of Stone or Ore by which they are more or leſs uſually accompanied; all which particulars however appertain ſolely to the Geological Collection.

Beſides in ſuch collections the different articles

articles of a ſpecies are often in great meaſure diſpoſed in a geographical manner: ſo the Saxon, Hungarian and the other *Opals* are placed together; and again in the *native Silver*, that from Himmelfurſt and Morgenſtern near Freyberg, lies along with the Furſtenberg, the Kongſberg, the Mexican, &c.

And laſtly, many Genera are partly arranged according to their uſe; for under the Genus *Silver*, beſides the genuine ores of that metal, there are uſually placed, the Fallow Ore, the argentiferous Galena, the White Ore, the Plumoſe Ore, the argentiferous Iron Ochres, and many others. In like manner under *Gold* occurs the auriferous Pyrites, the auriferous Blendes and others. The Gems alſo, Amethyſts Garnets and Tourmalines are moſt commonly claſſed together, as likewiſe are Chalcedony, Cornelian, Agate, Jaſper, Opal, Nephrites, Chryſopraſe and variegated Flintſtone; all which might be done with propriety in an œconomical, but by no means in a methodical Collection. Not

to mention the various productions of art as well as of the animal and vegetable Kingdoms, which were in former times placed in these collections, of which the ancient Museums or Catalogues afford numerous examples*.

I think by this time, I have sufficiently explained the proper object of methodical Collections, and the arrangement that seems best adapted to accomplish it. The methodical Collection, which I formed a year ago upon this plan, in the institute of the Mining Academy at Freyberg, may elucidate all that I have here advanced upon this kind of Collections.

The *Geographical* are of a very recent date, and indeed were first known in Saxony. I am acquainted at present with only two such collections. The one has been formed about 12 years by the Mining Academy at Freyberg, the other formerly composed the STIEGLITZ Collection at Leipzig, and was sold 6 years ago to the

* Many of which are mentioned by Wallerius, in his Historia Literaria Mineralogiæ. Holm. 1779. 8vo.

the Thereſian College in Vienna. The former* has been from its commencement, arranged on the foregoing principles by the preſent Bergmaſter LOMMER, at that time Inſpector to the Academy, as far as room and the information reſpecting the ſpecimens would permit. As it is at preſent under my inſpection, I ſhall endeavour to complete it, as far as theſe circumſtances will allow, agreeably to the rules delivered in the foregoing pages. At preſent, I have only reduced the Tranſilvanian, and Hungarian ſeries into order after B. BORNS† inſtructive Letters, and particularly the Schemnitz ſeries after the Zipſer Chart of the Mines of that Diſtrict.

In the STIEGLITZ Collection on the contrary, the Foſſils were placed indeed according to their reſpective Countries, which were not however diſpoſed in the beſt geographical Order, but it contained no

* This collection, the firſt of the kind, was inſtituted according to the plan, and under the direction of M. Pabſt Ohain, to whom therefore the credit of the Invention muſt be attributed.

† B. Borns Letters tranſlated into Engliſh, by R. E. Raſpe, Lond. 1777.

no ſpecimens of the different Rocks; and the Foſſils of each Land, Province or Mining Diſtrict, were arranged methodically, that is according to the Earth's, Stones, Metals*, &c. This collection therefore was not well adapted, either to the ſtudy of mineralogical Geography or that of Oryctognoſy. A *characteriſtical Collection*, I propoſed in my Eſſay on the external characters of Foſſils, the compoſition of that work having ſuggeſted to me the neceſſity of placing the Foſſils of my former methodical Collection in ſuch an order. I afterwards formed another collection of this kind in the Inſtitute of our Academy, which I uſe in my mineralogical Lectures, for the explication of the Characters of Foſſils. Theſe and another which Profeſſor LESKE of Leipzig, has formed for the ſame purpoſe, are I believe the firſt collections of the kind that have been inſtituted.

Geological and *Oeconomical Collections of Mi-*

* V. Catalogue under the Title VOLLSTANDIGER, Catalogus EINER SUITEN-MINERALIENSAMLUNG WELCHE AUS 4263 NUM. BESTEHT, &c. LEIPZIG, 3772, 8vo.

Minerals, are not yet to my knowledge in exiſtence; I have it however in contemplation to form one of the former kind, for the uſe of my Lectures in Geology.

IT would be doing injuſtice to the ingenious author of this Eſſay not to mention here the improvement which he has made in this arrangement, in the Preface to his admirable catalogue of the Ohain Cabinet of Minerals lately publiſhed.

After referring the reader to this Treatiſe, he finds it neceſſary, he ſays, to add to it what follows by way of ſupplement.

" As *Mineralogy*, if it be treated *fully* and *ſyſtematically*, in ſhort to the purpoſe, ought to be divided into *five* different *Doctrines*, namely *Oryctognoſy*, *Mineralogical Chemiſtry*, *Geognoſy*, *Mineralogical* Geography and *Oeconomical Mineralogy*; ſo ought alſo a complete Cabinet of Minerals (i. e. a Cabinet that is to ſerve for the ſtudy of Mineralogy in general) to conſiſt of as many particular *Collections*, as are neceſſary for the ſtudy of theſe different doctrines; and theſe Collections ought ſeverally to be

dif-

diſpoſed in perfect conformity with that doctrine to which they are devoted. Now *Oryctognoſy* requires for its ſtudy *two* particular Collections; namely the *characteriſtical*, for the ſtudy of the characters in the preparative part of Oryctognoſy, and the *methodical*, or properly ſpeaking *oryctognoſtical Collection* of *Minerals*, for the ſtudy of the families and ſpecies of Foſſils, in the applicative part of this doctrine.

For each of the remaining mineralogical doctrines on the contrary one collection ſuffices. In a *complete Mineral Cabinet* therefore, beſides the aforeſaid two collections, are included the *chemical*, the *geognoſtical*, the *geographical*, and the *œconomical* Collections.

APPENDIX.

MR. WERNER has neglected to mention the Collection of Minerals, formed by Michael Mercatus in the 16th century, and depoſited in the Vatican Gardens at Rome.

This Collection was begun about the year 1576, and compleated about the year 1583.

Mercatus was an eminent Phyſician, and had the care of the Botanical Garden at the Vatican.

The ſtudy of the Materia Medica probably firſt led him to the acquiſition of ſo much knowledge of the Mineral and Vegetable Kingdoms. It appears that at an early period of his life, he conceived the deſign of publiſhing a ſyſtem of Oryctognoſy,

tognoſy, that he ſpared neither pains nor expence in the collection of ſpecimens, and that he was favoured in this undertaking by a journey into Poland and Germany.

The firſt part of the intended work, finiſhed for the preſs, but left unpubliſhed by the untimely death of the author, has been reſcued from obſcurity, and communicated to the public by the liberality of Pope Clement the 11th, in the year 1717.

One of the plates which accompany the work, repreſents the Cabinets belonging to Mercatus's Collection, and their Arrangement in a large Hall of the Vatican.

There are 19 Cabinets, 13 of which are arranged on one ſide under the inſcription ΟΡΥΚΤΑ, and 6 on the other, under that of ΜΕΤΑΛΛΕΥΤΑ.

The Cabinets in the firſt Claſs, are marked as follows:

I. Terræ.
II. Sal et Nitrum.
III. Alumina.
IV. Succi Acres.

V. Succi

V. Succi Pingues.
VI. Marina.
VII. Lapides Terræ ſimiles.
VIII. Lapides Animalibus innati.
IX. Lapides ἰδιόμορφοι id eſt peculiari forma præditi.
X. Saxa et Lapidea facta.
XI. Marmora.
XII. Silices et Fluores.
XIII. Gemmæ.

The Cabinets in the 2d Claſs.

XIV. Aurum et Argentum.
XV. Aes.
XVI. Plumbum et Stimmi.
XVII. Terrum et σομωμα ſive Chalybs.
XVIII. Affinia metallis ſponte naſcentia.
XIX. Affinia metallis quæ in Fornacibus exiſtunt.

Prefixed to each of theſe Orders in the work, is an engraving of a Cabinet (or as it is here entitled Armarium) conſtructed upon a larger ſcale, and with conſiderable architectural embelliſhments. They are all uni-

uniform, and each contains 101 partitions whether pigeon holes or drawers uncertain.

Theſe are to be conſidered as on an improved conſtruction recommended by the Author, but not actually executed, which there is every reaſon to conclude the others were.

How far the Cabinets of Mercatus's Muſeum were filled and compleated according to his intention, does not appear, the whole being removed and diſperſed by his executors after his deceaſe; but from the teſtimony of many eminent men his contemporaries, a high idea may be formed of the number and rarity of the ſpecimens which they contained.

When M. Ferber viſited Rome in 1771, there was no trace remaining of this Collection.

PLAN

PLAN OF A COURSE OF LECTURES ON MINERALOGY.

INTRODUCTION.

Mineralogy in general.

1. PRELIMINARY remarks on the ſtudy of Natural Hiſtory in general, as conſiſting of the following particulars, viz.

A complete and accurate deſcription of all the parts and characters of Natural Bodies.

An inveſtigation of thoſe parts and characters which indicate the *eſſential differences* of Bodies, and on which may be founded a true and genuine diſtribution of them into their *Genera* and *Species*.

A judicious nomenclature and technical language, to convey the denominations and deſcriptions of the ſubjects of Natural Hiſtory, in a clear, conciſe and accurate manner.

2. The firſt general diſtribution of Natural Bodies into three great Claſſes, Animals, Vegetables, and MINERALS.

Circumſtances in which Minerals are eſſentially different from the two other Claſſes.

The opinion of thoſe Naturaliſts who attribute a vegetative Faculty to Foſſils.

No other properties than thoſe, which matter in general has been obſerved to poſſeſs, can be allowed in Mineralogy.

3. The more obvious properties of Mineral Subſtances explained.

CRYSTALLIZATION.

Opinions and Knowledge of the Ancients on this ſubject.

Fun-

Fundamental law of the ſimilar particles of all bodies, under proper circumſtances, to aſſume a regular and determinate form.

Theory of Cryſtallization.

Three ſtates of Aggregation obſervable in the Mineral kingdom, the complete or Cryſtal, the indeterminate, and the confuſed.

Inſtances of the great degree of Force which Minerals exert in overcoming the obſtacles to their cryſtallization and aſſuming their ſpecific Forms.

Numerous varieties of theſe Forms obſervable in the ſame Foſſil.

Romé de l'Iſle's Theory of the *primitive Forms*, and Abbe Haüy's of the *Nucleus* of Cryſtals.

HARDNESS

Does not depend upon the Denſity.

Compariſon of the Hardneſs of the ſame Foſſil in different ſtates of Aggregation.

The complete or cryſtallized ſtate does not ſeem to be invariably the hardeſt.

The different degrees of Force, by which the particles of diſſimilar Subſtances *cohere* in a ſtate of mixture, conſidered as the Hardneſs of ſome Foſſils.

DENSITY

Depends as well on the ſtate of Aggregation as on the Denſity of the original component particles.

4. The Evidences of a Chemical Combination.

Increaſe of the Denſity.

Alteration in the Cryſtalline Form.

Tranſparency.

Uncertainty of theſe Marks.

5. The Principles on which Minerals ought to be claſſed and arranged.

Diſſenſions of Mineralogiſts on this ſubject.

The inſufficiency of *external* characters for this purpoſe, and the neceſſity

ceſſity of adopting the chemical Method demonſtrated.

The genuine uſe of the external characters of Foſſils in Mineralogy, and the importance of their ſtudy.

6. A brief account of the principal Mineralogical ſyſtems, together with the Hiſtory of the Science.

Its importance in a political, œconomical, and philoſophical view, conſidered.

Some remarks on the preſent ſtate of this Science in Great Britain, and the means of promoting its cultivation.

PART THE FIRST.

DESCRIPTION OF FOSSILS.

7. Of the Characters of Foſſils in general, viz.
   - External.
   - Internal or Chemical.
   - Phyſical and
   - Empirical.

8. The advantages of the external Characters for the purpoſe of deſcribing Foſſils.
   - Their number.
   - Suitable Denominations.
   - Exact Definitions.
   - Syſtematical arrangement of them into their Genera and Species after their mutual relations.

10. Explication of M. WERNER's Syſtem of external Characters.

    According to this Syſtem there are ſeven *generical* external Characters, viz.

1. THE

1. The Colour.
2. The Cohesion.
3. The Unctuosity.
4. The Cold.
5. The Weight.
6. The Smell.
7. The Taste.

Colour. The degree of certainty belonging to this Character.

The various *Species* of Colours and their *Varieties* obſervable in the Mineral kingdom exhibited and explained.

Some other Modifications of Colour which are of uſe as characteriſticks of Foſſils.

Cohesion. Relative to this Character, Foſſils are diſtinguiſhed into Solid, Friable and Fluid.

Great complication of this Character which branches into the following particulars.

The external Appearance, compriſing { The Figure. / The Surface. / The Luſtre.

The Appearance of the Fracture
- The Luſtre of the Fracture.
- The Fracture.
- The Figure of the Fragments.

The Appearance of the ſeparate Pieces
- The Figure of the ſeparate Pieces.
- The Surface of do.
- The Luſtre of do.

Moreover

The Tranſparency
The Streak
The Stain
} Diſcovered as well as the foregoing by the Sight.

The Hardneſs
The Solidity
The Coherence
The Flexibility
The Adheſion to the Tongue
} by the Feeling.

The Sound - by the Hearing.

The *Specific* Characters of each of the foregoing branches, with their *Varieties*, explained and exhibited.

UNCTUOSITY. This Character not poſſeſſed by many Foſſils.

COLD.

Cold. The impreſſion of Cold to the touch of uſe in diſtinguiſhing artificial Gems from the natural ones.

Weight or Specific Gravity. Conſiderable reliance to be placed on this Character.

Smell. In ſome Foſſils ſpontaneous, in others excited by friction or moiſture.

11. Directions relating to the ſtudy of the external Characters, and the forming of a characteriſtical Collection of Foſſils for that purpoſe.

12. The method of drawing up deſcriptions of Foſſils according to the principles of this Syſtem.

Rules.

Examples.

PART

PART THE SECOND.

SYSTEMATICAL ARRANGEMENT OF FOSSILS.

Earths and Stones which are not viſible Aggregates of different Species.

13. The uſual conſtituent parts of Stones.
    Earths.
    Air.
    Water.
    Iron in different States.
    Saline principles.
14. The properties of the ſimple Earths, Siliceous, Argillaceous, Magneſian, Calcareous and Barytic Earths.
    Different degrees of purity in which theſe ſimple Earths are found.
15. Variety of Methods uſed by Nature in the compoſition of Stones.
    By the Aggregation of the particles of the ſame ſimple Subſtances. e.g. Quartz, Rock Cryſtal, &c.
    By the chemical combination of the elementary parts of Stones (13) in dif-

different numbers and proportion, according to their ſeveral affinities, degrees of ſaturation, &c. and the ſubſequent aggregation of the particles ſo compounded, e. g. Fluor, Spar, Feldſpar, &c.

By the intimate mixture without chemical Combination of the elementary parts of Stones, e. g. Many argillaceous Stones.

By more than one of theſe ways at the ſame time. Jaſper, Agates and the greateſt number of Stones.

16. The Affinities of the ſeveral ſimple Earths and Iron.

Affinity of Aggregation.

Poſſeſſed by the Siliceous Earth in the higheſt degree.

Affinity of Compoſition.

Difficulty and Importance of this reſearch.

Conjectures concerning the relative Affinities of the ſimple Earths and Iron.

17. The general Cauſes of the ſpontaneous Decompoſition of Stones.

In-

Incomplete Saturation.

Oxygenation of the Iron.

Attraction of the argillaceous Earth to Water.

18. On the chemical Analyſis of Earths and Stones.

The properties of compound Stones depend leſs on the number and qualities of the conſtituent Earths than on the proportions in which they are reſpectively combined.

19. The method adopted in the Lectures of demonſtrating the Subjects of the Mineral Kingdom.

Together with the Specimen there will be given,

1. The Synonyms of the principal Authors.
2. Its deſcription and Analyſis, determining its place in the Syſtem.
3. Its Natural, Oeconomical and Literary Hiſtory.

Siliceous Earths and Stones.

I. ZIRKON.

I. Zirkon.

A peculiar Earth combined with nearly $\frac{1}{2}$ of its weight of Siliceous.

Jargon of Ceylon.

II. Diamond Spar.

Siliceous Earth combined with $\frac{1}{2}$ of its weight of a peculiar Earth.

III. Gems.

Siliceous Earth in a peculiar ſtate combined with more than its weight of Argill and ſome mild calcareous Earth.

1. Diamond?
2. Ruby.
3. Saphire.
4. Emerald.
5. Cryſolite.
6. Aqua marina.
7. Topaz.
8. Hyacinth.

IV. Garnet.

Siliceous Earth combined with about $\frac{2}{3}$ of its weight of Argill, $\frac{1}{6}$ of calcareous Earth, and of Iron.

1. Gar-

1. Garnet.
2. Thumerſtone.
3. Beryl.

V. Schorl.

Siliceous and Argillaceous Earths combined in nearly equal proportion.

1. White Schorl.
2. Black Schorl. *Cockle.*
3. Electric. *Tourmaline.*

VI. Feldspar.

Siliceous Earth combined with nearly $\frac{1}{3}$ of its weight of Argill.

1. Common.
2. Compact.
3. Labradorſtone.
4. Moonſtone.

VII. Quartz.

Siliceous Earth united to a ſmall portion of Argillaceous.

1. Common.
2. Amethyſt.
3. Rock Cryſtal.
4. Praſe.

VIII. Chal-

VIII. Calcedony.

Siliceous Earth combined with nearly $\frac{1}{5}$ of its weight of Argill.

1. Calcedony.
2. Carnelian.
3. Opal.
4. Heliotrope.
5. Agate.

IX. Silex.

Siliceous Earth combined with more than $\frac{1}{5}$ of Argill and a ſmall portion of calcareous Earth.

1. Flint.
2. Petroſilex. *Chert.*

X. Zeolite.

Siliceous Earth looſely combined with above $\frac{1}{3}$ of its weight of Argill, ſome calcareous Earth, and a conſiderable portion of Water.

1. Mealzeolite.
2. Fibrous.
3. Radiated.
4. Laminated.
5. Lapis Lazuli.

XI. Cros-

XI. CROSSTONE.

Siliceous Earth combined with ½ of its weight of Barytic Earth and of Argill, and a conſiderable portion of Water.

XII. NEPHRITE.

Siliceous Earth combined with nearly an equal weight of Magneſia.

Jade.

Argillaceous.

I. CLAY.

Argillaceous Earth mixed with Siliceous.

Porcellane, Pipe and *Potter's* Clay.

II. LITHOMARGA.

Argillaceous Earth united to a conſiderable quantity of Siliceous, ſome calcareous Earth, Magneſia and Iron.

Fuller's Earth. Terra Lemnia.

III. MARTIAL CLAY.

Clay (1) mixed with a conſiderable portion of Iron.

Bole. Terre verte of Brentonico.

IV. JASPER.

IV. Jasper.

A. Ferruginous Clay intimately mixed with Calcedony. *True Jaſper.*

B. Ferruginous Clay intimately mixed with Quartz. *Zinople.*

V. Schistus.

Argill intimately mixed with nearly an equal portion of ſiliceous Earth, ſome Calcareous, Magneſia and Iron.

1. Argillaceous. *Roof Slate.*
2. Aluminous. *Alum Shale.*
3. Bituminous. *Brandſchiefer.*

VI. Mica.

Argill combined with nearly the ſame quantity of Siliceous and a ſmall portion of Magneſia and Iron.

VII. Hornblend.

Argillaceous Earth united with about twice its weight of Siliceous, nearly ¼ of Magneſia and of calcareous Earth, and a conſiderable portion of Iron.

1. Common Hornblend.
2. Hornblend Slate.
3. Labrador-Hornblend.
4. Baſaltic Hornblend.

VIII. BASALTES.

Argill united to above three times its weight of ſiliceous Earth, about $\frac{1}{2}$ of calcareous Earth, ſome Magneſia and near twice its weight of Iron.

1. Baſaltes.
2. Wacké. *Toadſtone.*

Magneſian.

I. TALC.

Magneſia intimately combined with above its weight of ſiliceous Earth.

1. Common Talc.
2. Indurated.
3. Meerſchaum.

II. STEATITES.

Magneſia combined with twice its weight of ſiliceous Earth and a conſiderable portion of Argill, Air and Water.

III. SERPENTINE.

Magneſia combined with more than its weight of ſiliceous Earth and a conſiderable portion of calcareous Earth and Iron.

IV. As-

IV. Asbestus.

Magneſia combined with above twice its weight of ſiliceous Earth, $\frac{1}{2}$ of its weight of calcareous Earth, a ſmall portion of Argill and Iron.

1. Mountain Cork.
2. Amianthus.
3. Common Aſbeſtus.
4. Mountain Wood.
5. Rayſtone.
6. Tremolite.

V. Cyanite.

Magneſia combined with about 5 times its weight of Argill and with an equal quantity of ſiliceous Earth.

Calcareous.

I. Aerated.

Calcareous Earth combined with fixed Air.

1. Cryſtallized. *Spar.*
2. Stalactite. *Piſolite. Flos Ferri*, &c.
3. Limeſtone. *Marble.*
4. Chalk.

II. Brown Spar.

Calcareous Earth united to Manganeſe.

Spath perlé of R. de l'Iſle.

III. Swinestone.

Mild calcareous Earth penetrated with Bitumen.

IV. Marl.

Mild calcareous Earth mixed in various proportions with common Clay.

1. Earthy.
2. Indurated.

V. Compound Spar.

Mild calcareous Earth mixed with Magneſia.

Vid. Kirwan's Min. p. 39.

VI. Gypsum.

Calcareous Earth ſaturated with the Vitriolic Acid.

1. Cryſtallized. *Selenite.*
2. Striated. *Gypſum.*
3. Common. *Plaſter Stone.*

VII. Fluor.

Calcareous Earth ſaturated with the Fluor Acid.

1. Cry-

1. Cryſtallized. *Fluor.*
2. Common. *Derbyſhire Spar. Blue John*, &c.

VIII. PHOSPHORATED.

Calcareous Earth ſaturated with the Phoſphoric Acid.

1. Cryſtallized. *Apatite.*
2. Common. *Marmaroſh Earth.*

IX. BORACIC.

Calcareous Earth combined with the Acid of Borax.

Boracite.

Barytical.

I. AERATED.

Barytes combined with Fixed Air.

Witherite.

II. VITRIOLATED.

Barytes ſaturated with the Vitriolic Acid.

1. Cryſtallized. *Heavy Spar. Bononian Stone.*
2. Stalactitical.
3. Common. *Marmor metallicum. Cawk.*

Saline Subſtances.

20. Of Salts in general, their component parts and great attraction to Water.

Acids and Alkalies ſeldom found pure and uncombined in nature.

The principal Acids which occur in the mineral kingdom.

The places where Salts are uſually found native.

I. VITRIOLATED,

1. Mineral Alkali. *Glauber's Salts.*
2. Volatile Alkali. *Glauber's Secret amm. Salt.*
3. Magneſia. *Epſom Salts.*
4. Argill. *Alum.*
5. Metals. *Vitriols.*

II. NITRATED,

Vegetable Alkali. *Nitre.*

III. MURIATED,

1. Mineral Alkali. *Common Salt. Sal gem*, &c.
2. Volatile Alkali. *Sal ammoniac.*

IV. AERATED,

Mineral Alkali. *Natron.*

V. BORAX.

V. Borax.

The Mineral Alkali combined with a peculiar Acid.

Tincal. Borax.

Inflammable Subſtances.

21. The compoſition of Bitumens and diſtinguiſhing Properties.

Artificial imitation of them.

Originate probably from organic ſubſtances.

I. Petroleum.

Oleaginous matter combined with an Acid.

1. Pure. *Naptha.*
2. Viſcid. *Maltha.*
3. Compact. *Aſphaltum. Jet.*
4. Elaſtic. *From Caſtleton, Derbyſhire.*

II. Coal.

Petroleum with an earthy baſis.

1. Stone Coal.
2. Coal blend.
3. Vegetable Coal. *Bovey Coal.*
4. Peat.

III. AMBER.

Petroleum combined with a peculiar Acid.

IV. HONEYSTONE.

Analyſis unknown.

V. SULPHUR.

Baſe of the Vitriolic Acid.

Native. Common. Volcanic.

VI. PLUMBAGO.

Baſe of fixed Air united to a ſmall portion of Iron.

Black Lead. Graphite.

Metallic Subſtances.

22. Of the nature of Metallic ſubſtances. Their Denſity, Opacity, peculiar Luſtre, &c.

Simple ſubſtances capable of uniting with vital Air in various proportions.

23. The different ſtates in which Metals are found in the Earth.

Native.

Native.
Combined with Sulphur and Arſenic.
Alloyed with each other.
Calciform, Spathoſe, combined with various Acids, &c.
The Veins and Matrices of Ores.

A. Metals with a brittle regulus.

I. MOLYBDENA.

Combined with Sulphur. *Molybdena.*

II. MANGANESE.

1. Native.
2. Calciform and mixed with Iron. *Black Calx of M. Red and white do.*

III. ANTIMONY. Spec. Gr. 6.860.

1. Native.
2. Arſenical. The Regulus alloyed with Arſenic.
3. Combined with Sulphur. *Grey Ore of A.*
4. Calciform. *Red A. White A.*

IV. ZINC. S. G. 6.862.

1. Combined with Sulphur. *Blend. Yellow. Brown. Black.*

2. Calci-

2. Calciform. *Lapis Calaminaris.*
3. Combined with fixed Air. *Spathoſe.*

V. Cobalt. S. G. 7.700.

1. Alloyed with Arſenic. *Arſenical.*
2. Combined with Arſenic, Sulphur and Iron. *White and Grey Ores of C.*
3. Combined with Sulphur.
4. Calciform. *Black ſcoriform C.*
5. Combined with the Arſenical Acid. *Red Bloom of C.*

VI. Arsenic. S. G. 8.308.

1. Native.
2. Combined with Sulphur and Iron.
3. Calx of A. combined with a conſiderable portion of Sulphur. *Realgar.*
4. Calx of A. combined with a leſs quantity of Sulphur. *Orpiment.*
5. White Calx.

VII. Nichel. S. G. 9.000

1. Combined with Sulphur, Arſenic and Iron. *Kupfernickel.*
2. Calciform. *Green Calx of N.*

VIII. Bismuth.

VIII. Bismuth. S. G. 9.670.

1. Native.
2. Combined with Sulphur. *Biſmuth-Glance.*
3. Calciform.

IX. Tungsten?

1. Combined with Manganeſe and Iron. *Wolfram.*
2. Acid of T. combined with calcareous Earth. *Tungſten. Lapis ponderoſus.*

B. Metals with a malleable Regulus.

X. Tin. S. G. 7.264.

1. Combined with Sulphur, Iron and Copper. *Tin Pyrites.*
2. Tin Stone. *Tin Cryſtal. Tin Grains.*
3. Wood Tin.

XI. Iron. S. G. 7.800.

1. Native.
2. Combined with Sulphur. *Pyrites.*
3. Magnet.
4. Magnetical Iron Stone.
5. Specular Iron Ore. *Iron-Glance.*
6. Red

6. Red Iron Stone. *Hæmatites.*
7. Brown Iron Stone.
8. Spathoſe Iron Ore.
9. Argillaceous Ore.
10. Bog Ore.
11. Blue Earth. *Native Pruſſian Blue.*
12. Green Earth.
13. Emery.

XII. COPPER. S. G. 8.867.

1. Native.
2. Combined with Sulphur. *Vitreous Copper Ore.*
3. Azure Ore.
4. Yellow Ore. *Copper Pyrites.*
5. White Copper Ore.
6. Grey Copper Ore.
7. Black Copper Ore.
8. Combined with fixed Air. *Red Copper Ore.*
9. Blue Copper Ore. *Lapis Armenus.*
10. Green Copper Ore. *Malachite.*
11. Olive Copper Ore.

XII. LEAD. S. G. 11.352.

1. Native?

2. Com-

2. Combined with Sulphur. *Galena. Lead glance.*
3. Combined with Antimony, Sulphur and Iron.
4. Calciform. *Friable and indurated Lead Ochres.*
5. Combined with fixed Air. *Spathoſe Lead Ore.*
6. Combined with the phoſphoric Acid.
7. Combined with the Molybdenic Acid.
8. Combined with the Vitriolic Acid.

XIV. MERCURY. S. G. 14.110.

1. Native.
2. Calx of M. combined with Sulphur. *Cinnabar.*
3. Hepatic. *Liver Ore.*
4. Combined with pure Air. *Native Red Precipitate.*
5. Combined with Marine Acid and a ſmall quantity of Vitriolic Acid. *Corneous Quickſilver.*

XV. SILVER. S. G. 10.552.

1. Native.

2. Alloyed

2. Alloyed with Arſenic and Iron.
3. Combined with Sulphur. *Vitreous Ore.*
4. Black Silver Ore.
5. Combined with the Marine Acid. *Corneous Ore.*
6. Combined with Arſenic and Sulphur. *Red Ore.*
7. Combined with Lead, Sulphur, Regulus of Antimony and Iron. *White Silver Ore.*
8. Some other argentiferous Ores, which are not properly Silver Ores, and yet are worked for that metal.

XVI. GOLD. S. G. 19.640.

1. Native.
2. Diſſeminated in Pyrites.
3. Combined with Sulphur, Antimony, Arſenic, Lead and Iron. *Nagyag Ore.*
4. White Gold Ore.

XVII. PLATINA. S. G. 21.000.

Mixed with Iron in Grains. *Martial Platina.*

PART THE THIRD.

GEOGNOSY or [illegible] of the [illegible] structure.

[illegible] the Figure and Mag[illegible] of the Earth.

Voyages round the World.

Measures of the degrees of Latitude and Longitude.

25. Distribution of the Surface into Land and Water.

General Resemblance of the two Continents.

Of the Passage by the North into the Pacific Ocean.

Improbability of a Continent lying near the South pole.

26. Of Mountains in general.

Their Connection and Stretch.

Their Heights. Barometrical Measurement.

Line of perpetual Congelation in different Latitudes.

Of Glaciers and Icebergs.

27. Of

27. Of the STRATA of the Earth.

Primary.

Secundary.

Alluvial.

Volcanic.

Their relative Antiquity and order of Stratification.

28. The PRIMARY Strata.

Their high Antiquity.

Evidences of their formation *viâ humidâ.*

Total abſence of Petrifactions and all traces of organized bodies.

GRANITE.

GNEISS.

MICACEOUS SLATE.

ARGILLACEOUS SLATE.

PORPHYRY SLATE.

PORPHYRY.

BASALTES.

ALMONDSTONE or TOADSTONE.

SERPENTINESTONE.

PRIMARY LIMESTONE.

QUARTZ.

TOPAS ROCK.

29. The

29. The SECONDARY Strata or regularly ſtratified Mountains. *Flotzgebirge* of the Germans.

The different Beds of which theſe Mountains are compoſed, their direction and inclination.

The immenſe number of Petrifactions both of the Animal and Vegetable Kingdoms which are diſcovered in theſe Strata.

LIMESTONE.

SANDSTONE.

1. Common.
2. Grey Wackè of the Hartz.
3. Puddingſtone.

COAL.

CHALK.

ROCK SALT.

PLASTERSTONE.

IRONSTONE.

30. The ALLUVIAL Strata.

The recent formation of theſe Strata.

The enormous Blocks of the Primary Mountains which are found ſcattered on the alluvial ſtrata, at an

immenſe diſtance from their native beds.

Of the Foſſil Bones of Siberia and the Ohio diſcovered in theſe Strata.

STREAM WORKS, &c.

NETHERLAND.

1. Sandy. *Red Sandſtone.*
2. Loamy.
3. Fenny.

31. Of Petrifactions.

The great elevations at which theſe Foſſils are found.

Their general diſperſion over moſt parts of the Globe.

For the moſt part they appear to have been generated, lived and died, in the beds wherein they are found.

Of the immenſe number of marine bodies which are found in a foſſil State, but a very few analogous Species have been diſcovered to exiſt at preſent, and that in a different Climate and a remote Sea.

Examination of the Queſtion whether

ther Calcareous Strata be intirely the fabrication of marine animals.

The Arrangement of *Extraneous* Foſſils and of each in particular.

A. Petrifactions of ANIMALS.

a Land Animals.
- α The Teeth.
- β The Bones.
- γ The Horns.

b Sea Animals.
- α Ichtyolites.
  - I. Intire.
  - II. Vertebræ.
  - III. Teeth. *Gloſſopetræ.*
- β Teſtaceous Animals.
  - I. Cochlites.
    - 1. Ammonites.
    - 2. Turbinites.
    - 3. Belemnites.
  - II. Conchites.
    - 1. Chamites.
    - 2. Terebratulites. *Anomia.*
    - 3. Mytilites
    - 4. Gryphites.

III. Echinites.
1. The bodies of Echini.
2. The Spines.

γ Corallites.
I. Madrepores.
II. Retipores.

δ Zoophytes.
I. Encrinites.
II. Entrochites.

B. VEGETABLE BODIES.

a Phytotypes.
b Lithoxyla.

32. Of Mineral VEINS, and the manner in which Metallic Subſtances are diſpoſed in the bowels of the Earth.

33. Of VOLCANIC Mountains.
Peculiar Form and Situation of Volcanic Mountains.
Phænomena which precede and which attend an Eruption.
The Productions of Volcanos.
LAVA.
1. Compact, containing *Cryſolites*, *Garnets*, and *Cryſtals of Hornblend*.
2. Cel-

2. Cellular. *Pumice.*

VITRIFICATIONS. *Iſland Agate.*

SLAGS and CINDERS.

1. Looſe. *Puzzolana. Traſs.*

2. Coherent. *Tufa.*

SALTS chiefly *ammoniacal.*

GASES of various kinds.

Submarine Volcanos.

Rocks altered by Subterraneous Fire.

Is the origin of Baſaltes and Toadſtone to be attributed to Fire or Water?

Deſcription of extinct Volcanos and their diſtinguiſhing marks.

Great number of theſe ancient Volcanos diſcovered in various Countries.

34. Of EARTHQUAKES and Subterraneous Fire.

Phænomena of Earthquakes.

Conjectures concerning their cauſe.

In what Strata is the ſeat of Subterraneous Fire uſually placed?

35. Of the SEA.

Increaſe of the height of the Mediterranean

terranean and decreaſe of the height of the Baltic Sea.

Conjectures concerning the Saltneſs and Bitterneſs of the Sea.

The Temperature of Sea Water.

Ice Iſlands.

Phoſphoreſcence of the Sea.

Its principal Motions.

36. The origin of SPRINGS.

Petrifying Wells.

Mineral Waters.

Hot Springs.

37. Of RIVERS.

Theory of Running Water.

Gradual Elevation of the Beds of Rivers.

38. Of the ATMOSPHERE and Meteors.

Winds regular and irregular.

Temperature in different Latitudes.

39. A view of the principal changes which are known from experience to happen to the ſurface of the Earth.

By the Motions of the Sea.

By Rivers and Floods.

By the Viciſſitude of Seaſons.

By

By the Decay of Rocks.

By Earthquakes and Subterraneous Fire.

40. Inſufficiency of theſe cauſes to account for the Formation of Continents and the other great natural Phænomena of our Globe.

Phænomena which indicate the exiſtence of Agents whoſe operation at preſent ſeems to have ceaſed, or is at leaſt undiſcovered by us.

The Analogies from which we may reaſon concerning the nature of theſe Agents.

41. Of the Antiquity of the Earth.

Phænomena which indicate the preſent State of our Continents not to be very ancient.

42. View of the Syſtems of the principal Authors in Coſmogony.

Opinions of the Ancients.

Syſtems of the Moderns.

1. Founded on an univerſal Deluge, BURNET, WOODWARD, WHISTON.

2. Founded on the operation of Earth-

Earthquakes and Subterraneous Fire. RAY, HOOK, MORO, WHITEHURST, &c.

3. The Theories of BUFFON, LEIBNITZ, MALLET, &c.